

REMARKS

Upon entry of the present amendment, claims 6, 10, 14 and 16-27 are pending in the application, of which claims 6, and 17 are independent. Claims 26-27 have been added.

Examiner Interview

Applicant thanks the Examiner for the helpful and courteous telephonic interview that was conducted on February 12, 2009 with applicant's undersigned representative. During the interview, applicant requested clarification with respect to the Examiner's comment on page 5 of the Office Action concerning applicant's explanation of a small manually operable shot peening nozzle used for treating large casting dies as presented in the Amendment dated January 28, 2009, i.e., the Examiner emphatically states "**However, there is no support in the specification for the alleged procedure of shot peening treatment using a small, manually-operable shot peening nozzle for treating large casting die** (emphasis in original)", and the Examiner essentially disregards applicant's explanation of the small manually operable shot peening nozzle in maintaining his rejection of the claims. In response, the Examiner repeated his concerns about proper / adequate support for the explanation of the meaning for the original and amended claim language "5-10 seconds/5cm²" which involves use of the small nozzle as discussed in the Amendment. The Examiner also stated that further explanation of and support for the use of the small nozzle discussed in our amendment G could be added in the 132 Declaration, whereas any such explanation / discussion would be considered as impermissible "new matter" if it is added to the specification. No agreement was reached, although applicant is submitting a revised Declaration Under 37 CFR 1.132 which includes a discussion / explanation of applicant's use of small manually operable shot peening nozzle used for treating large casting dies in practicing the claimed invention, and the associated language "5-10 seconds/5 cm²" as used in the present specification.

Amendments Presented

New claims 26, 27 are similar to claims 23, 25 except that the steel material is defined as SCM420 chrome molybdenum steel material

Applicant respectfully submits that the added claim limitations are fully supported by the original disclosure, including: the abstract and the exemplary embodiment discussed in the specification. Applicant also respectfully submits that no new matter is introduced by the present amendment.

Response to Office Action

The above-identified Office Action has been reviewed, the references carefully considered, and the Examiner's comments carefully weighed. In view thereof, the present Amendment and a revised Declaration under 37 CFR 1.132 are submitted.

It is respectfully contended that by the present amendment and Declaration, all bases of rejection set forth in the Office Action have been traversed and overcome. Reconsideration and withdrawal of the rejections set forth in the Office Action are respectfully requested.

The Present Invention

The present invention relates to a casting die and a surface treatment for the die resulting from an important discovery made by the applicant in relation to the surface roughness of the used casting die when it is being treated to increase its residual stress. With the casting die of the present invention it is possible to advantageous decrease the frequency of replacement of the die in comparison to conventional casting dies subjected to conventional treatments, or in other words to give the die a longer service life as compared to conventional casting dies and conventional treatments for such dies, thereby reducing the production costs of products cast using the die. Also, the sulphonitriding diffusion layer can be easily formed on the cavity surface by the sulphonitriding

treatment that is conducted after a first shot peening treatment and before a second shot peening treatment.

Claim Rejections – 35 USC § 103

1. At item 3 of the Office Action the Examiner has rejected claims 6,10,17-19 and 21-25 under 35 USC 103 as being unpatentable over Masahiko et al (845) in view of Yoshitaka (610). It is the Examiner's position that Masahiko (845) substantially shows the invention as claimed except for the use of nitrosulphurizing process for coating the die surface and that Masahiko fails to disclose the surface roughness. However, the Examiner states that it would have been obvious to employ the nitrosulphurizing process of Yoshitaka on the die of Masahiko. The Examiner further alleges that it is *expected* that the surface roughness of Masahiko would be the same as in the present application since the process parameters are similar to that of the application.

2. At item 3 of the Office Action the Examiner has rejected claims 14,16 and 20 under 35 USC 103 as being unpatentable over Masahiko et al (845) in view of Yoshitaka (610) and further in view of Nakagawa et al. It is the Examiner's position that it would have been obvious to provide the hydrogen gas and ammonia gas as taught by Nakagawa in the nitriding process of Masahiko or nitrosulphurizing process of Yoshitaka for better control of the reaction.

In such rejections set forth in the Office Action the Examiner has essentially repeated / maintained his rejections from prior Office Actions. Inexplicably, the Examiner's rejections do not address / acknowledge the Declaration under 37 CFR 1.132 which was filed together with the Amendment of January 28, 2009 in which one of the present inventors, Hiroaki Koyama, discusses tests that were conducted comparing the presently claimed invention to a casting die treated according to the process disclosed in the Masahiko reference, and which provide direct evidence

supporting applicant's arguments that the presently claimed invention is patentably distinct from the process of the Masahiko reference.

Furthermore, at item 5 of the Office Action, the Examiner provides the following rebuttal to the arguments presented in the Amendment dated January 28, 2009. Specifically, the Examiner provides the following rebuttal:

- a) the Examiner asserts that while JP '845 does not disclose the same surface roughness and residual stress as claimed, if a different steel material such as SKD61 and SCM, which is harder than the material disclosed in JP '845 using the parameters disclosed by JP '845, it is expected that the claimed surface roughness and residual stress as claimed would be achieved
- b) the Examiner essentially rejects / disregards applicant's explanation of the meaning of the claim language "5-10 seconds/5cm²", asserting that there is "no support in the specification for the alleged procedure of shot peening treatment using a small, manually-operable shot peening nozzle for treating a large casting die", and that "...if the procedure and duration of peening were so critical to the instant invention, then there would be a question of adequacy of the disclosure in the specification."
- c) the Examiner (again) disregards / discounts applicant's arguments as to why the claimed surface roughness could not be achieved by optimizing the procedure disclosed in JP '845, and that a surface roughness significantly greater than 8µm was conventionally recognized to provide an important advantage in the art at the time of applicant's invention, and instead repeats his earlier assertion that "... it would have been obvious to obtain the die surface of JP '845 as smooth as possible to optimize the casting result."

- d) Responding to the applicant's argument that there is no evidence to support the Examiner's allegation regarding selection of different material and process parameters to obtain the claimed residual stress in the process of the Masahiko reference, the Examiner notes the applicant's admission (paragraphs [002], [007]) that it is conventional to use different material for making the steel die. The Examiner further alleges that "SCM material is stronger than SKD61", Masahiko uses SKD61 as die material, and it would have been obvious to obtain higher residual stress when SCM material is used in Masahiko's process.
- e) Responding to applicant's argument that Masahiko only discloses use of a single shot peening treatment for a used casting die, the Examiner asserts that it would have been obvious that two shot peening steps would achieve a higher residual stress, and that it would have been obvious to include another shot peening treatment after the nitriding treatment should a higher residual stress be needed.

Applicant's Response:

Upon careful consideration, and in light of the (revised) declaration of Hiroaki Koyama under 37 CFR 1.132 filed herewith, applicant traverses the Examiner's rejections of the present claims, and submits that each of the present claims is patentably distinct over the applied references whether considered singly or in combination, based on the following.

Again, applicant respectfully submits that Masahiko does not, in fact, teach two shot peening steps / treatments lasting 5-10 seconds each, and which result respectively in a surface roughness of $\leq 16 \mu\text{m}$ and $\leq 8 \mu\text{m}$, as well as a respective compressive residual stresses of $\geq 1000 \text{ MPa}$ and $\geq 1200 \text{ MPa}$ as defined in present claims 6, 17, contrary to the Examiner's asserted position. Moreover, this distinction is very significant because it gives the casting die a longer

service life as compared to conventional casting dies and conventional treatments for such dies, thereby reducing the production costs of products cast using the die. This distinction is understood from the actual disclosure of Masahiko, as it would be understood by persons of ordinary skill in the art, and from an actual test performed comparing a steel casting die processed according to the presently claimed invention to a steel casting die processed according to Masahiko's disclosed process, as discussed in the attached declaration of Hiroaki Koyama under 37 CFR 1.132 and the following. Such persons would also not consider the claimed surface treatment method and resulting steel die to be obvious based on the Masahiko disclosure because Masahiko's method / die are consistent with conventional understanding and practice in the art at the time of applicant's invention, and essentially teaches away from the claimed invention.

Shot Peening Time

Masahiko expressly discloses at his paragraph [0025] a shot peening treatment of a test piece 1 including a first shot peening operation in which carborundum particles 50-100 μm are projected at the test piece for 60 seconds at an injection pressure of 0.3 MPa, and a second shot peening operation (after nitriding treatment) in which glass beads 1-50 μm diameter are projected at the test piece for 60 seconds at an injection pressure of 0.4 MPa. Masahiko's disclosed process involving a 60 second shot peening of the entire test piece surface is consistent with conventional practice at the time of the invention. See paragraphs 7-8 of the Declaration of Hiroaki Koyama enclosed herewith (hereinafter "Declaration").

In a previous explanation of the rejection in the last Office Action the Examiner explained his interpretation of why Masahiko's 60 second shot peening operation meets the claimed invention involving shot peening operations of 5-10 seconds, e.g., in Masahiko the total treatment time of 60 seconds is applied to the treated surface having a diameter of 58 mm, such that a total treated area

of JP '845 is equal to 26.4 cm^2 , Examiner then interprets a total peening treatment time of JP '845 to be about 11 seconds/ 5 cm^2 , which the Examiner asserts is about the same as applicant's claimed treatment time of 5-10 seconds which is more fully discussed as "5-10 seconds/ 5 cm^2 " in applicant's disclosure.

Applicant respectfully submits that the Examiner's interpretation of the claimed limitation is incorrect because the actual shot peening treatment time applied to any specific area of the surface of the die cavity is "5-10 seconds" as expressly claimed, contrary to the actual shot peening time of 60 seconds which Masahiko applies to the entire surface area of the test piece 1, whereas this distinction is very significant because it results in a different surface roughness and residual stress for the claimed invention compared to the surface roughness and residual stress resulting from Masahiko's disclosed process, as discussed further below and in paragraphs 11-16 of the Declaration.

On the other hand, language "5-10 seconds/ 5 cm^2 " as set forth in the present specification pertains to an unusual manner in which the present inventors carried out a shot peening operation on a large size casting die using a small nozzle which only permitted an area of 5 cm^2 of the die cavity to be treated at any given time, as discussed further below and in paragraphs 9-10 of the Declaration.

Shot Peening

Generally, a conventional shot peening treatment is performed to an object or a test piece placed in a cavity of a shot peening apparatus, and balls/particles are shot against the entire surface of the object at a specific shot pressure for a predetermined time period. That is, in a general, conventional shot peening treatment, if the shot peening time is set to 60 seconds as in JP '845, shot balls /particles are shot against the entire surface of the object for the entire period of 60 seconds. See paragraphs 7-8 of the Declaration.

In the present invention, because the object is a casting die which is rather large in size, the inventors found that most shot peening apparatus are not large enough to accommodate the casting die therein. Therefore, unlike in the conventional treatment procedure, it is difficult to secure a shot peening apparatus for carrying out the normal practice of concurrently shooting balls / particles over the entire surface of the object (casting die) for a given time period. Thus, the present inventors used a small, manually-operable shot peening nozzle for treating different portions of the casting die in sequential operations, i.e., the balls are shot from the nozzle toward one part of the casting die for the predetermined time of 5-10 seconds, then balls are shot from the nozzle toward another portion of the casting die for 5-10 seconds, and this is repeated until all portions of the casting die have been uniformly treated for 5-10 seconds. See paragraph 9 of the Declaration.

In the actual, experimental procedures conducted by the inventors, the size of the treatment portion was 5cm^2 , and this is reflected by the discussion at paragraphs [0047] – [0052] of the published application, as well as in the language of claims 21-22 when these claims were originally introduced in Amendment-D (although the language “ 5cm^2 ” has since been deleted from the claims). This recitation does not mean that any given shot peening time is merely divided by the surface area to be treated, as the Examiner has interpreted and applied relative to the disclosure of JP ‘845. Instead, the shot peening treatment time for the entire surface being treated is uniformly within the specified range of 5-10 seconds according to the present invention, whereas the language “ 5cm^2 ” merely reflects the particular, unusual condition which the inventors used for treating the large sized casting die because they did not have a treatment apparatus which could hold/enclose the die such that its entire surface could be concurrently subjected to the shot peening treatment for 5-10 seconds. See paragraph 10 of the Declaration.

The above explanation is reasonable and would be considered as accurate by persons skilled in the art when the shot peening conditions are used to specify the surface roughness of the object. It is not conventional to define / describe a shot peening process in terms of time / unit area, but rather it is conventional to define / describe a shot peening process in terms of time of the shot peening operation which is performed on the entire object being treated. Again, see paragraph 10 of the Declaration. In contrast, if the Examiner's interpretation of the present claim language were considered to be correct, i.e., the treatment time is to be divided by a unit surface area, this could lead to absurd results. For example, if an object having an entire surface area of 5 cm^2 was subjected to the shot peening treatment, the entire surface is hit by the balls uniformly for 5-10 seconds, whereas if an object having an entire surface area of 4 m^2 was subjected to such shot peening treatment, the entire surface area is hit by the balls uniformly for a day or a day and a half. Persons of ordinary skill in the art would not consider the Examiner's interpretation to be reasonable or appropriate.

As understood from the foregoing, persons of ordinary skill in the art would understand / interpret the discussion of JP '845 regarding shot peening treatment time to mean that the average, uniform treatment time for the entire surface of the casting die is 60 seconds. Moreover, such persons would also understand that a treatment time of 60 seconds is in line with conventional practice, but is very much different than the claimed treatment time of 5-10 seconds for any given surface area.

Again, the language “/5 cm^2 ” has been deleted from claims 21, 22 to avoid the unintended confusion.

The Claimed Treatment Times Are Not Taught By or Obvious In View of JP '845

Again, applicant respectfully submits that the claimed peening treatments steps of 5-10 seconds which result respectively in a surface roughness of $\leq 16 \mu\text{m}$ and $\leq 8 \mu\text{m}$, as well as a respective compressive residual stresses of $\geq 1000 \text{ MPa}$ and $\geq 1200 \text{ MPa}$ as defined in present claims 6, 17 are not taught or made obvious by the conventional treatment method disclosed in JP '845, and in fact result is a significant advantage - prolonged service life for the casting die, and corresponding cost reduction for parts cast using the die.

Differences between the claimed method steps (casting die) and those of JP '845 are discussed at paragraphs 11-16 of the enclosed Declaration. In the field of surface treatment, research is conducted to improve the useful life of metal products such as casting dies, and shows that shot peening prolongs the useful life. Therefore, shot peening is widely used as the surface treatment for prolonging the service life of metal products. See paragraph 6 of the Declaration.

However, after a shot peening treatment a small surface roughness of not more than $8 \mu\text{m}$ would not be obtained according to the conventional treatment procedures, including that of JP '845. Rather, a surface roughness of significantly larger value such as $50 \mu\text{m}$ and more, which is shown by actual tests conducted by the applicant as discussed below and at paragraphs 15-16 of the Declaration.

In this regard, it is not true or a matter of common knowledge in the art that it is desirable to maintain the surface of a casting die as smooth as possible, as alleged by the Examiner in his rejections. At the time the present invention was made, a surface roughness which is significantly larger than $8 \mu\text{m}$ has a conventionally recognized benefit in relation to a casting die consistent with the disclosure of Masahiko. Particularly, for a casting die a molten metal flowing into the die has an oxide coating on its surface, and when the die has a surface roughness of approximately $50 \mu\text{m}$,

the oxide coating will be caught and broken by the die surface, so that a clean molten metal will flow in the die improving the heat conduction speed between the molten metal and the die. Persons skilled in the art at the time of applicant's invention understood the foregoing, and also understood that when the surface roughness is not more than 8 μm , the oxide coating of the molten metal will not be caught and broken by the die surface, and the heat conduction might slightly become worse compared to a casting die with a normal surface roughness of approximately 50 μm . Thus, at the time applicant made the present invention, a surface roughness (maximum height) of approximately 50 μm was considered enough to "obtain a better surface quality for the cast article". In other words, if those of ordinary skill in the art at the time of the invention intended to maintain a casting die surface as smooth as possible only in view of "improving a surface quality for the cast article", then such persons would have tried to make the surface roughness approximately 50 μm , and not to try any obtain a surface roughness of a smaller value, consistent with convention understanding. See paragraph 13 of the Declaration.

Contrary to conventional understanding, such as reflected in the disclosure of Masahiko, the present inventors found that the die cavity surface should be maintained as smooth as possible to increase a heat transfer rate between the cast metal and die surface, and also to obtain a better surface quality for the cast article. For this purpose, the inventors intentionally made the surface roughness not more than 8 μm and determined that they could do this by setting the shot peening time for a period in a range of 5-10 seconds in each of first and second shot peening treatments. See paragraph 14 of the Declaration.

Moreover, as discussed at paragraphs 15-16 of the declaration, actual experiments conducted based on the claimed method involving shot peening treatments of 5-10 seconds and an injection pressure of 0.49 MPa and the method of JP '845 using shot peening treatments of 60 seconds and

injection pressures of 0.3 MPa and 0.4 MPa, show that the resultant surface roughness of the claimed invention is 8 μm , whereas that of JP '845 is 61 μm .

Also, JP 845 shows a residual stress of less than 1000 MPa even after the two shot peening treatments. This is contrary to claims 6 and 17 which specifically set forth the residual stress is 1000 MPa or larger after the second peening step, contrary to claims 6, 17 which define a residual stress of at least 1200 MPa.

The Claimed Surface Roughness is not a Matter of Optimization

Applicant respectfully traverses the Examiner's assertion that the claimed surface roughness is an *obvious matter of optimization through routine experimentation* because *none of the applied references ever indicates that surface roughness is a result-oriented variable, which should be optimized*. MPEP 2144.05(B) states that "A particular parameter must first be recognized as a result-effective variable, i.e., a variable which achieves a recognized result, before the determination of the optimum or workable ranges of said variable might be characterized as routine experimentation". *In re Antonie*, 559 F.2d 618, 195 USPQ 6 (CCPA 1977). It is respectfully submitted that the art in this instance does not recognize the surface roughness as a result-effective variable. See also *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

Here, conventional wisdom is that a surface roughness of approximately 50 μm achieved with shot peening treatment times of 60 seconds is appropriate, whereas applicant has gone away from the conventional practice / wisdom by applying the shot-peening treatment for a reduced duration of 5-10 seconds. The claimed features are non-obvious as compared to conventional teachings, including JP '845, and provide an unexpected, useful result. Thus, the claimed features are unobvious because there is no showing that it would be a matter of routine experimentation to

change from the conventionally desired range of approximately 50 μm (MPEP2144.05) in order to find something more optimal.

Rebuttal to the Examiner's Response

Relative to the Examiner's rebuttal a) and d), applicant respectfully submits that the Examiner's premise regarding relative hardness of different material is incorrect. The Examiner asserts that SCM material is stronger than SKD61, with reference to the SCM material described at the second paragraph on page 3 of the present application. Masahiko describes that SKD61 has a Vickers hardness Hv of 450 to 550. In the case of SCM 420 used in the embodiment disclosed in the present application the Vickers hardness Hv is 262 to 352. Thus, SCM is not stronger than SKD61.

Relative to the Examiner's rebuttal b) applicant respectfully disagrees with the Examiner that there is "no support" in the specification for applicant's explanation involving a nozzle which treats a small surface area of 5cm^2 at any given time. The non-conventional nature of such language (itself) provides some support for the explanation that has been provided. The non-conventional nature of the language may lead to different or ambiguous interpretations of the meaning of the language, e.g., applicant's explanation which is very different from the Examiner's interpretation. Moreover, applicant's proffered explanation provides an interpretation that would be considered reasonable and accepted by persons of ordinary skill in the art, whereas the Examiner's interpretation could lead to absurd results as discussed above and would not be considered reasonable or accepted by persons of ordinary skill in the art.

On the other hand, applicant respectfully traverses the Examiner's statement regarding "...a question of adequacy of the disclosure in the specification" because the original specification

consistently emphasizes the significance of the advantageous surface roughness (and compressive residual stress) achieved by the unique shot peening treatments according to the invention.

Relative to the Examiner's rebuttal b) applicant has shown that a surface roughness of $\leq 16 \mu\text{m}$ after one peening step (which advantageously permits the sulphurizing diffusion layer to be easily formed on the cavity surface), and a final surface roughness of $\leq 8 \mu\text{m}$ are contrary to a conventionally desirable surface roughness for casting dies as understood by persons skilled in the art at the time applicant made the present invention. On the other hand, the Examiner has not provided any evidence to support his allegation that it would have been desirable to make the surface as smooth as possible at the time of applicant's invention. The conventionally desirable surface roughness of $50 \mu\text{m}$ is a teaching away from the claimed invention, and hence an indication of non-obviousness of the claimed invention as discussed above. Moreover, the references and other evidence of record do not otherwise establish surface roughness within the claimed ranges as a result-oriented variable to be optimized.

Relative to the Examiner's rebuttal c), the Examiner's allegation is not supported by Masahiko's actual disclosure or by any other evidence of record.

Based on the foregoing, applicant respectfully submits that the invention as defined by each of the present claims includes features which are neither disclosed nor suggested in any of the applied references Masahiko, JP'610 and Nakagawa et al., considered either singly or in combination. Further, the claimed invention including these features obtains an excellent effect that cannot be expected from Masahiko and/or JP'610, i.e., significantly prolonged service life of the casting die. Therefore, the present invention is not obvious over the disclosures of JP'610, Masahiko and Nakagawa et al., considered either singly or in combination.

For all of the foregoing reasons, applicant requests reconsideration and withdrawal of the rejections of claims 6, 10, 14 and 16-25 under 35 USC §103(a).

Other Matters

New claims 26-27 are believed to be allowable based on the foregoing arguments regarding claims 6 and 17, as well as on the merits of the additional features recited in the new claims.

Conclusion

Based on all of the foregoing, applicant respectfully submits that all of the rejections set forth in the Office Action are overcome, and that all of the pending claims are believed to be allowable over all of the references of record, whether considered singly or in any reasonable combination. It is applicant's contention that no possible reading of the references, either singly or in any reasonable combination, can be viewed as teaching applicant's claimed invention. For all of the above mentioned reasons, applicant requests reconsideration and withdrawal of the rejections of record, and allowance of each of the pending claims.

The application is now believed to be in condition for allowance, and a notice to this effect is earnestly solicited. If any issues remain unresolved, or if the Examiner feels that the prosecution of the present application could be expedited by a telephone discussion, applicant encourages the Examiner to telephonically contact applicant's undersigned representative to resolve any such issues remaining in the prosecution of the application.

Favorable consideration is respectfully requested.

Respectfully submitted,



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